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Title of Invention:

Disposable diaper

Abstract:

Purpose of Invention: To provide a disposable diaper with excellent fitting ability, low skin irritating ability, and excellent forming workability.

Make-up of Invention: A disposable diaper, characterized in that, in a disposable diaper in an folded-out form, which is provided with a liquid-permeable front surface sheet 2, a liquid-impermeable rear surface sheet 3, and an absorbant material 4 with the ability to hold liquids between these sheets, and has a pair of adhesive fastening tapes 10 on the left and right edges of the part B which goes on the back of the folded-out form, the aforementioned fastening tapes 10 are provided with an elastic non-woven fabric comprising an elastic composite fiber with a hard elastic component consisting of a crystalline polypropylene as its first component and a thermoplastic elastomer as its second component.

Claims:

(1) A disposable diaper, characterized in that, in a disposable diaper in an folded-out form, which is provided with a liquid-permeable front surface sheet, a liquid-impermeable rear surface sheet, and an absorbant material with the ability to hold liquids between these sheets, and has a pair of adhesive fastening tapes on the left and right edges of the part which goes on the back of the wearer of the diaper, the aforementioned fastening tapes are provided with an elastic non-woven fabric comprising an elastic composite fiber with a hard elastic component consisting of a crystalline polypropylene as its first component and a thermoplastic elastomer as its second component.

(2) A disposable diaper in accordance with Claim (1), characterized in that the aforementioned fastening tapes are provided with mechanical fasteners, consisting of a concave part and a convex part, as a means of fastening them.

Detailed Explanation of Invention:

Industrial Field of Application

This invention concerns a disposable diaper with excellent fitting ability, low skin irritating ability, and excellent forming workability.

Prior Art and Problems That the Invention Is to Solve

Disposable diapers which have been widely used up to now have been provided with a liquid-permeable front surface sheet, a liquid-impermeable rear surface sheet, and an absorbant material with the ability to hold liquids between these sheets. Recently, in order to further improve the fitting ability and leak-preventing ability of these diapers, it has been proposed that the aforementioned fastening tapes be made elastic themselves.

However, there has been the problem up to now that, when the fastening tapes are made elastic, they touch the wearer's skin when the diaper is put on and the skin is irritated because the tapes are formed from ordinary rubber, etc.

Moreover, ordinary rubber and similar materials have the problem of poor forming workability, which makes the productivity inferior.

Therefore, the purpose of this invention is to provide a disposable diaper with excellent fitting ability, low skin irritating ability, and excellent forming workability.

Means of Solving These Problems

The inventors performed careful investigations in order to solve these problems. As a result, they discovered that the aforementioned purpose can be accomplished by means of a disposable diaper which is provided with a specific elastic non-woven fabric.

This invention is based on this discovery; it provides a disposable diaper which is characterized by the fact that, in a disposable diaper in an folded-out form, which is provided with a liquid-permeable front surface sheet, a liquid-impermeable rear surface sheet, and an absorbant material with the ability to hold liquids between these sheets, and has a pair of adhesive fastening tapes on the left and right edges of the part which goes on the back of the wearer, the aforementioned fastening tapes are provided with an elastic non-woven fabric comprising an elastic composite fiber with a hard elastic component consisting of a crystalline polypropylene as its first component and a thermoplastic elastomer as its second component.

Practical Embodiment of This Invention

The disposable diaper of this invention will be explained in detail below. The disposable diaper of this invention is characterized by the fact that the fastening tapes are provided with a specific elastic non-woven fabric.

The aforementioned elastic non-woven fabrics used in this invention comprise elastic composite fibers with hard elastic components consisting of crystalline polypropylenes as its first component and a thermoplastic elastomer

as its second component.

The aforementioned crystalline polypropylenes used as the hard elastic component which is the aforementioned first component are not particularly limited as long as they have hard elastic properties. Desirable examples of these crystalline polypropylenes are propylene homopolymers, copolymers of ethylene with propylene as the principal ingredient, and copolymers of α-olefins with propylene as the principal ingredient.

The aforementioned crystalline polypropylenes should have a degree of crystallization of 40% or higher. If the degree of crystallization is less than 40%, the elongation recovery rate of the fiber will be insufficient in some cases. This degree of crystallization is calculated on the basis of the energy required to melt the crystals, measured by the DSC (differential scanning calorimetry) method.

The aforementioned crystalline polypropylenes should have melt indices in the range of 1–200 g/10 min, preferably 3–50 g/10 min. If the aforementioned melt index is less than 1 g/10 min, the melt viscosity will be too high and spinning will become more difficult in some cases. If the melt index exceeds 200 g/10 min, the melt viscosity will be too low, and the spun thread will break before it is made in to a fiber. Therefore, neither of these is desirable. Furthermore, the aforementioned melt index is measured according to ASTM D-1238, at 230°C, with a load of 2.16 kgf.

Moreover, the aforementioned crystalline polypropylenes have weight average molecular weights of 10,000–1,000,000, preferably 20,000–600,000, so that they will easily show elasticity and the aforementioned composite fiber can be easily spun.

The aforementioned are elastomers which are used as the second component mentioned above is generally composed of soft segments, which have molecules with rubber elasticity, and molecule-binding components (hard

segments), which prevent plastic deformation. The aforementioned thermoplastic elastomers can be classified by the kinds of hard segments in them; in this invention, it is desirable to use styrene elastomers, olefin elastomers, vinyl chloride elastomers, urethane elastomers, ester elastomers, amide elastomers, syndiotactic poly(1,2-butadiene), and poly(trans-1,4-isoprene). Among these, urethane and ester elastomers are especially desirable.

Examples of the aforementioned urethane elastomers are ones which contain, as the hard segments, blocks with urethane bonds, and as the soft segments, blocks with polycarbonate polyols, ether polyols, caprolactone polyesters, or adipate polyesters. Moreover, the aforementioned ester elastomers are ones which contain, as the hard segments, blocks with aromatic polyesters, and as the soft segments, blocks with aliphatic polyethers or polyesters.

Moreover, as examples of the aforementioned thermoplastic elastomers, it is especially desirable to use ethylene-α-olefin copolymers produced according to publicly known methods, using publicly known metallocene compounds as catalysts, considering workability, cost, resistance to light, chemical resistance, skin irritating ability, etc. In the aforementioned ethylene-α-olefin copolymers, one can use α-olefins with carbon numbers in the range of 3–30, e.g., propylene, 1-butene, 1-pentene, 1-hexene, 1-octene, 1-heptene, 4-methyl-1-pentene, 4-methyl-1-hexene, 4,4-dimethyl-1-pentene, octadecene, etc. Among these, 1-hexene, 1-octene, 1-heptene, and 4-methyl-1-pentene are desirable. Desirable proportions of the ethylene and the α-olefins in the aforementioned ethylene-α-olefin copolymers are 40–98 wt % ethylene and 60–2 wt % α-olefins.

In this invention, thermoplastic plastics or oil ingredients, etc., may be added to these thermoplastic elastomers in order to improve the melt flowability of the thermoplastic elastomers.

It is desirable for the aforementioned thermoplastic elastomers to have

elongation recovery rates of 50% or more, when they are stretched 100%; because this makes it possible for the aforementioned elastic non-woven fabric to follow the movements of the body and not be broken when it is used in applications such as clothing.

Moreover, the aforementioned thermoplastic elastomers are preferably ethylene-α-olefin copolymers which have permanent strains of 50% or less, and especially desirably 0–30%, as well as hysteresis ratios of 5.0 or lower, and especially desirably 1.0–3.5. If the aforementioned permanent strain is 50% or less, the range of solidification when the aforementioned elastic non-woven fabric is used in various kinds of products can be widened, and if the aforementioned hysteresis ratio is 5.0 or lower, the applicability of the aforementioned elastic non-woven fabric becomes better. On the other hand, if the aforementioned permanent strain exceeds 50%, or the aforementioned hysteresis ratio exceeds 5.0, it is not desirable, because the fitting ability due to the fastening tapes which are provided with the aforementioned elastic non-woven fabric will be reduced in some cases.

The aforementioned permanent strain and hysteresis ratio are measured as follows.

Method of measurement of permanent strain: In the same manner as in the method of measuring the hysteresis ratio described below, the sample being measured is stretched 100% and [held in] chacks; the distance between these chacks is measured as the initial length of the sample; the proportion (%) of the length which cannot be relaxed (the length of the part which was stretched and make longer than the initial length) with respect to the initial length when the sample was stretched 100% is obtained, and this is taken as the permanent strain.

Method of measurement of hysteresis ratio: In order to determine the elasticity of a sample, the hysteresis ratio is measured by using an elongation tester. That

is, a sample (sheet) formed from the aforementioned thermoplastic elastomer is set, based on JIS L1015 and L1096; next, the sample is stretched 100% at a rate of 300 mm/min and an elongation curve is drawn, after which the sample is relaxed at the same rate. At the point the distance between the chacks reaches the initial length of 100 mm, the relaxation is stopped, and a relaxation curve is drawn. The areas under the elongation and relaxation curves are measured and substituted into the following formula to calculate the hysteresis ratio:

hysteresis ratio = (area under elongation curve)/(area under

In the aforementioned composite fiber, it is desirable for the content of the first component to be in the range of 5–70 wt % and the content of the second component to be 95–30 wt %, and it is preferable for the content of the first component to be in the range of 10–60 wt % and the content of the second component to be 90–40 wt %; it is especially preferable for the content of the first component to be in the range of 10–50 wt % and the content of the second component to be 90–50 wt %. If the content of the first component exceeds the aforementioned upper limit or the content of the second component is less than the aforementioned lower limit, the elasticity of the aforementioned composite fiber is insufficient in some cases; if the content of the first component is less than the aforementioned lower limit or the content of the second component exceeds the aforementioned upper limit, the area in which the second component is exposed on the surface of the aforementioned composite fiber becomes larger and the quality of the feel of the product is lowered in some cases. In addition, composite fibers of the sheath-core type become difficult to spin. Therefore, it is desirable for these values to be within the ranges mentioned above.

The aforementioned composite fibers may have forms which are not particularly limited, as long as these forms can exhibit elasticity. Desirable such

forms include side-by-side, divided (with the fiber cross-section divided into arcs), and sheath-core (concentric and eccentric) forms. These composite fibers can be manufactured by forming the aforementioned forms of composite fibers by using the aforementioned first and second components, by publicly known spinning methods.

The aforementioned composite fibers produced by the aforementioned publicly known spinning methods may be made into a non-woven fabric by forming a web directly after the spinning is performed, or the web may be formed after the spinning is performed, beginning at the point that the elastic property becomes greater, and the spun thread is the subjected to a specific stretching treatment. As the conditions of this stretching treatment, the stretching temperature should be in the range of 20–130°C, and the stretching ratio is in the range of 1–6-fold. The heating of the aforementioned elastic composite fibers can be performed by using, for example, hot air, steam, infrared heating means, etc.

The aforementioned composite fibers should have diameters of 1–20 denier, preferably 2–6 denier. If the fiber diameter is less than 1 denier, the spinnability during the spinning process will be lowered, and it will become difficult to form a fiber in some cases. If it exceeds 20 denier, the hand of the aforementioned elastic non-woven fabric will become poor when it is used. Therefore, it is desirable for the diameter to be within the aforementioned range.

It is desirable for the aforementioned composite fiber to have elongation recovery rates of 20–100% when they are stretched 100%, and especially desirably 50–100%. If the aforementioned elongation recovery rate is less than 20%, the ability of the elastic non-woven fabrics to follow the movements of the body will be insufficient when the fabrics are used in applications such as clothing.

The aforementioned composite fabrics may be used in the form of short

fibers such as staple fibers, or in the form of long fibers, such as continuous filaments.

It is especially desirable for 100% of the aforementioned elastic non-woven fabrics to be formed from the aforementioned composite fibers, but they may also be spun as mixtures with other fibers. If they are spun as such mixtures, the elastic non-woven fabric may contain preferably 30 wt % or more, and especially desirably 50 wt % or more, of the aforementioned composite fiber. IF the quantity of the composite fibers is less than 30 wt %, the elasticity of the elastic non-woven fabric will be markedly lowered and in some cases it may break. The other fibers which may be spun together with the aforementioned composite fibers may be fibers which are not caused to degenerate by the heat treatments which are performed in the process of forming the non-woven fabric, e.g., thermoplastic synthetic fibers, such as polyolefins, polyesters, and polyamides; natural fibers, such as cotton, hemp, or wool; and various kinds of reconstituted fibers such as rayon or acetate or binder fibers which can be fused by the aforementioned heat treatments.

The aforementioned elastic non-woven fabrics can be produced, for example, by methods using carding machines or by the direct sheet method. Specifically, they can be produced by resin bonding, mixed spinning with binder fibers, heat rolling, water needling, etc. Examples of the aforementioned web forming methods which can be used when short fibers such as staple fibers are used as the composite fibers are methods of forming webs by open weaving of the composite fibers using carding machines. Moreover, when long fibers such as continuous filaments are used as the composite fibers, the method of forming the web by transporting the aforementioned melt-spun composite fibers using high-speed air flows and accumulating and open-weaving them on moving nets (the spun bond method).

An example of a method for forming non-woven fabrics by heat-treating the webs formed in this manner (thermal bond methods) is the method of passing the web through a through-air dryer [*suruu ea doraiya*] and fusing the points of intersection of the fibers constituting the web by means of hot air, thus forming multiple points of adhesion. In this case, while the temperature of the hot air and the quantity of it fed in depend on the kinds of fibers constituting the web, the weight of the web, and the speed at which it is traveling, the temperature of the hot air should ordinarily be 140–170°C and the rate of flow of the air should be 0.5–3 m/min. Furthermore, another method of performing this heat treatment is to perform heat embossing by using a pair of embossing rolls, one of which is engraved and the other of which is smooth. In this case, the heat embossing can be performed by heating either or both of these rolls. The heating temperature of the rolls should be 120–170°C. If the heating is performed at a higher temperature than this, the aforementioned web will adhere to the embossing rolls in some cases. The embossing rolls used may be iron rolls with various patterns engraved on their surfaces. On the other hand, one can also use paper rolls, rubber rolls, silicon rubber rolls, urethane rubber rolls, metal rolls, etc., as the aforementioned smooth rolls. Examples of the patterns on the aforementioned engraved rolls may be pin, dots, turtle-shell, lattice, vertical stripes, horizontal stripes, braided, or other patterns; these patterns are not particularly limited. The linear pressure of the embossing rolls in this heat embossing process depends on the weight of the web, the speed of travel, and the embossing temperature, but it is generally desirable for it to be in the range of 10–150 kg/cm.

The aforementioned elastic non-woven fabric should have an elongation recovery rate of 40–100%, preferably 60–100%, when it is stretched 20%. If the aforementioned elongation recovery rate is less than 40%, then the fabric will not

be able to follow the movements of the body sufficiently well when it is used in applications such as clothing and its resistance to these movements will be great in some cases.

It is desirable for the weight of the aforementioned elastic non-woven fabric to be in the range of 5–200 g/m², and especially desirably 15–80 g/m². If it is less than 5 g/m², the aforementioned elongation recovery rate will be smaller, and in some cases insufficient; if it exceeds 200 g/m², the non-woven fabric formation by the thermal bond method will become difficult, and there will be disadvantages with respect to cost. Therefore, it is desirable for the weight to be within the aforementioned range.

Furthermore, it is desirable for the thickness of the aforementioned elastic non-woven fabric to be in the range of 0.05–5 mm, preferably 0.2–2 mm, under a load of 0.5 g/cm². If the thickness is less than 0.05 mm, the fiber density will be high and the elastic properties will be insufficient in some cases; if it exceeds 5 mm, an unpleasant feeling will be produced when the elastic non-woven fabric is used in applications such as clothing. Therefore, it is desirable for the thickness to be within the aforementioned range.

Next, an embodiment of the disposable diaper of this invention will be described in detail using the attached drawings. Fig. 1 is a partially cut-away view of the back side of an embodiment of the disposable diaper of this invention; Fig. 2 is an enlarged perspective view of the fastening tape used in the disposable diaper of Fig. 1; and Fig. 3 is an enlarged perspective view of another embodiment of the fastening tape used in this invention.

In Fig. 1, the disposable diaper 1 of this embodiment is provided with a liquid-permeable front surface sheet 2, a liquid-impermeable rear surface sheet 3, and an absorbant material 4 with the ability to hold liquids between these sheets. Furthermore, a pair of adhesive fastening tapes 10 are provided on the

left and right edges B1 and B2 of the part B which goes on the back of the wearer. Furthermore, a landing [*randingu*] tape 9 to which the aforementioned fastening tapes adhere is provided in approximately the center of the part which goes on the abdomen of the wearer.

Furthermore, a leak-preventing sheet 8a is fixed to the outer side of the diaper, on the aforementioned front surface sheet 2, and solid guards [*gaado*] 8 which have free ends 8b are placed on the inner side of the diaper. The aforementioned leak-preventing sheet may be of any publicly known type, without any particular restrictions, but it is preferable to use hydrophobic non-woven fabrics, non-woven fabrics treated to make them water-repellent, etc. This kind of make-up is the same as that of conventional disposable diapers; the various parts of the diaper may be made of publicly known materials, without particular restrictions.

Moreover, the aforementioned fastening tapes 10 are provided with the aforementioned elastic non-woven fabric 16.

To give a more detailed description, the aforementioned fastening tape 10 is composed of a main tape body 11 and a release tape (not shown) which touches and protects the surface of the fastening part 13, on which an adhesive is applied, when the fastening tape is not used; the [fastening tape 10] is fixed to the front surface sheet 2 of the diaper and has a surface which is free to peel off. Furthermore, the aforementioned main tape body 11, as shown in Fig. 1, is composed of an end part 12, which is connected to the rear surface sheet 3 and fixed to it; an elastic part 15 which is formed from the aforementioned elastic non-woven fabric 16 (see Fig. 2) and is continuous with the aforementioned end part 12; an fastening part 13, which is formed by applying an adhesive to one side (the surface sheet side) and is continuous with the aforementioned elastic part 15; and a pulling part 14, which is formed by folding the front end of the

fastening part 13. In the structure of this fastening tape 10, as will be described in more detail with reference to Fig. 2, the aforementioned end part 12 and the aforementioned elastic part 15 are formed as one body from the same material, that is, the aforementioned elastic non-woven fabric 16, and the aforementioned elastic part 15 and the aforementioned fastening part 13 are connected by a connection part 18.

Moreover, the aforementioned fastening part 13 is formed from a film sheet and an adhesive, which form ordinary fastening tapes. Moreover, the aforementioned connection part 18 is formed by connecting the aforementioned elastic part 15 and the aforementioned fastening part 13 by ordinary connection methods, without particular restrictions, but in this embodiment they are connected by partially adhering the ends of the aforementioned elastic part 15 and the aforementioned fastening part 13 by heating and fusing them, etc. Furthermore, the aforementioned end part 12 may be bonded to the aforementioned part of the diaper which goes on the back of the wearer by partially adhering it by heating and fusing, or it may be bonded by heat embossing or ultrasound sealing, etc.

Moreover, elastic parts 20 and 30 are formed on the waist part 5, which is placed on the waist of the wearer of the diaper, and the leg parts 6, which are placed around the legs of the diaper. Moreover, elastic parts 40 are placed on the aforementioned free ends 8b in the aforementioned solid guard parts 8. The elastic parts 40 are placed on the free ends 8b on the inner sides of the diaper in the said solid guard parts 8 by folding the end sides of the aforementioned leak-preventing sheets 8a into a tubular shape and covering them by the aforementioned leak-preventing sheets 8a.

Since the disposable diaper of this embodiment is formed as described above, the diaper can be fastened by extending the fastening parts 13 of the main

body of the tape 11. Thus, the diaper has excellent fitting ability and leak-preventing ability, and the aforementioned fastening tape has little irritating ability even when it touches the wearer of the diaper when the diaper is put on.

Next, another embodiment of the fastening tape used in the disposable diaper of this invention will be described in detail with reference to Fig. 3. The fastening tale 10A with the form shown in Fig. 3 has a widened end part 12A, and the elastic part 15A widens in the direction towards the end part 12A. Therefore, its fitting ability is increased. Moreover, it is the same as the fastening tape embodiment shown in Figs. 1 and 2 in all other respects, and the explanation given above is applicable in the suitable respects.

Furthermore, the disposable diaper of this invention is not limited to the embodiment shown in Fig. 1; it may be changed in various ways as long as it does not depart from the gist of this invention. Moreover, all of the aforementioned fastening tape 10 may be formed from the aforementioned elastic non-woven fabric. Furthermore, as the aforementioned fastening tape 10, one may also use one provided with a mechanical fastener, consisting of a concave part and a convex part, on the aforementioned fastening part (the front surface sheet of the diaper) as a means of fastening it. The convex or concave part used in this case may be any such parts which are ordinarily used, without particular restrictions. Furthermore, when the aforementioned convex part is used as the means of fastening, the aforementioned landing tape 9 is concave, and when the aforementioned concave part is used as the means of fastening, the aforementioned landing tape 9 is convex.

Effects of Invention

The disposable diaper of this invention has a low ability to irritate the skin and excellent forming workability.

Brief Explanation of Drawings

Fig. 1: partially cut-away view of the back side of an embodiment of the disposable diaper of this invention;

Fig. 2: enlarged perspective view of the fastening tape used in the disposable diaper of Fig. 1;

Fig. 3: enlarged perspective view of another embodiment of the fastening tape used in this invention.

Explanation of Symbols:

1	Disposable diaper
2	Front surface sheet
3	Rear surface sheet
4	Absorbant material
10	Fastening tape
11	Main tape body
12	End part
13	Fastening part
14	Pulling part

Fig. 1

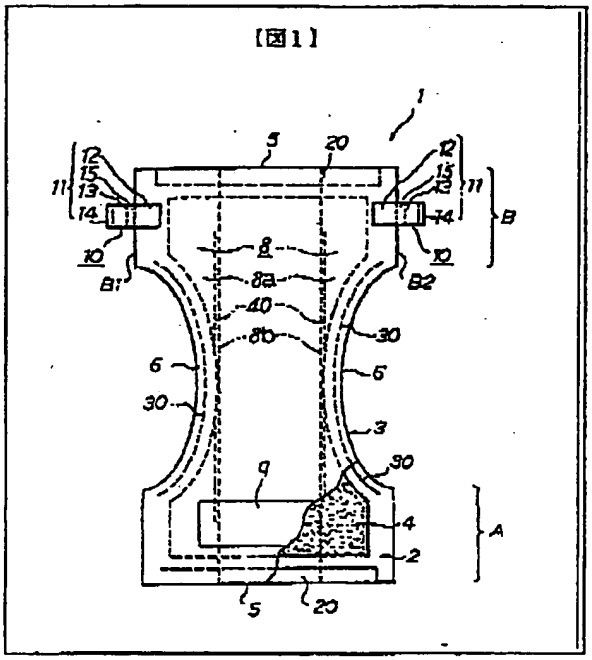

Fig. 2

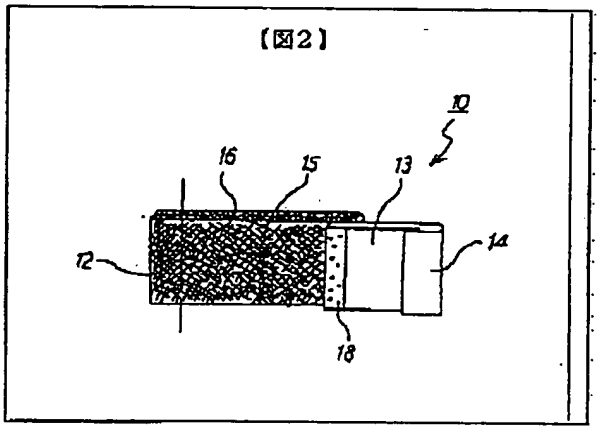

Fig. 3